ADVENTURE SCIENTISTS

EXPLORE. COLLECT. PROTECT.

TIMBER PROJECT

FIELD SEASON REPORT 2018

WORLD RESOURCES INSTITUTE

NICFI

DNA4 Technologies LLC

NM STATE UNIVERSITY


CHRISTY CAROVILLA

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TIMBER PROJECT

PREPARED BY **ANYA TYSON**
TIMBER PROJECT MANAGER
ADVENTURE SCIENTISTS

SUMMARY

The 2018 pilot season of Adventure Scientists' Timber Tracking Project engaged 110 volunteers in a large-scale botanical collection effort to deter poaching of bigleaf maple, a hardwood valued for its ecological importance and for its attractiveness in furniture- and guitar-making. Our volunteers succeeded in sampling from 1,023 bigleaf maples across California, Oregon, Washington, and British Columbia. The resulting collections will fuel the research and development of multiple wood identification technologies. With the potential to tie suspect lumber back to its point of origin, these technologies represent critical assets in the battle against the illegal timber trade. In addition to recruiting, training, and managing volunteers, Adventure Scientists developed

field protocols in consultation with the partners below, secured permits, and provided quality control of physical specimens and metadata for this project. As a key collaborator, World Resources Institute (WRI) connected Adventure Scientists with scientific partners including geneticists from DNA4 Technologies, New Mexico State University (NMSU), and the United States Forest Service (USFS) and mass spectrometry specialists from the United States Fish and Wildlife Service's (USFWS) Forensics Laboratory.

KELSEY SCHERER

PROJECT CONTEXT

The illegal timber trade has global and devastating impacts on the climate, biodiversity, and human dignity (May and Clough 2017). This $100-billion criminal sector increases CO_2 in the atmosphere, drives species towards extinction, and bankrolls dangerous political corruption (Nelleman et. al. 2014). On the international market, up to three out of ten finished wood products have been illegally sourced (Nelleman 2012).

Unlike with categorically banned items like ivory or tiger pelts, the legality of timber products is not apparent at first glance. As a result, illegally harvested timber is easily and often presented under a false identity or mixed in with shipments of legal wood. By revealing the species and harvest location of questionable lumber, genetic- and chemical-based wood identification technologies hold great potential to improve transparency in global supply chains. However, the development and implementation of such technologies hinges on access to a reference library against which to compare unknown samples. The Timber Tracking Project seeks to assemble these critical reference libraries for a variety of species through the collection of research-grade specimens across large geographic areas.

In 2018, the Timber Tracking Project launched with a focus on bigleaf maple (*Acer macrophyllum*) along the Pacific Coast of North America. As a species that is easily identified, ecologically significant, and at risk of continued poaching, the bigleaf maple represented a perfect study subject for this project's pilot season. With leaves that may grow larger than a dinner plate, the aptly-named bigleaf maple plays a critical role in providing wildlife habitat, stabilizing riparian soils, and shading streams (Minore and Zasada 1990). In about one in 20 bigleaf maples, the wood grain displays an intricate patterning, known as "figure," which is extremely desirable for use in the electric guitar trade and also in the production of furniture, luxury dashboards, and other musical instruments. Despite the successful federal prosecution of an unscrupulous Washington State mill operator and several poachers in 2015, the rural and remote areas where many bigleaf maples grow continue to present opportunities to timber thieves.

KELSEY SCHERER

PROJECT DESIGN

FIELD PROTOCOLS

In collaboration with Dr. Brook Milligan (NMSU), Dr. David Erickson (DNA4 Technologies), and Meaghan Parker-Forney (World Resources Institute), Adventure Scientists produced two distinct protocols for this project: 1) a detailed protocol for the collection of leaves, branch cross-sections, tree cores, and museum-quality voucher specimens intended for our specialized “Wood Crew” volunteers, and 2) a simpler protocol for the collection of leaf segments only for our "Leaf Crew" volunteers. Protocols were based in part off of methods described in Funk et. al (2017) and Grissino-Mayer, H.D. (2003).

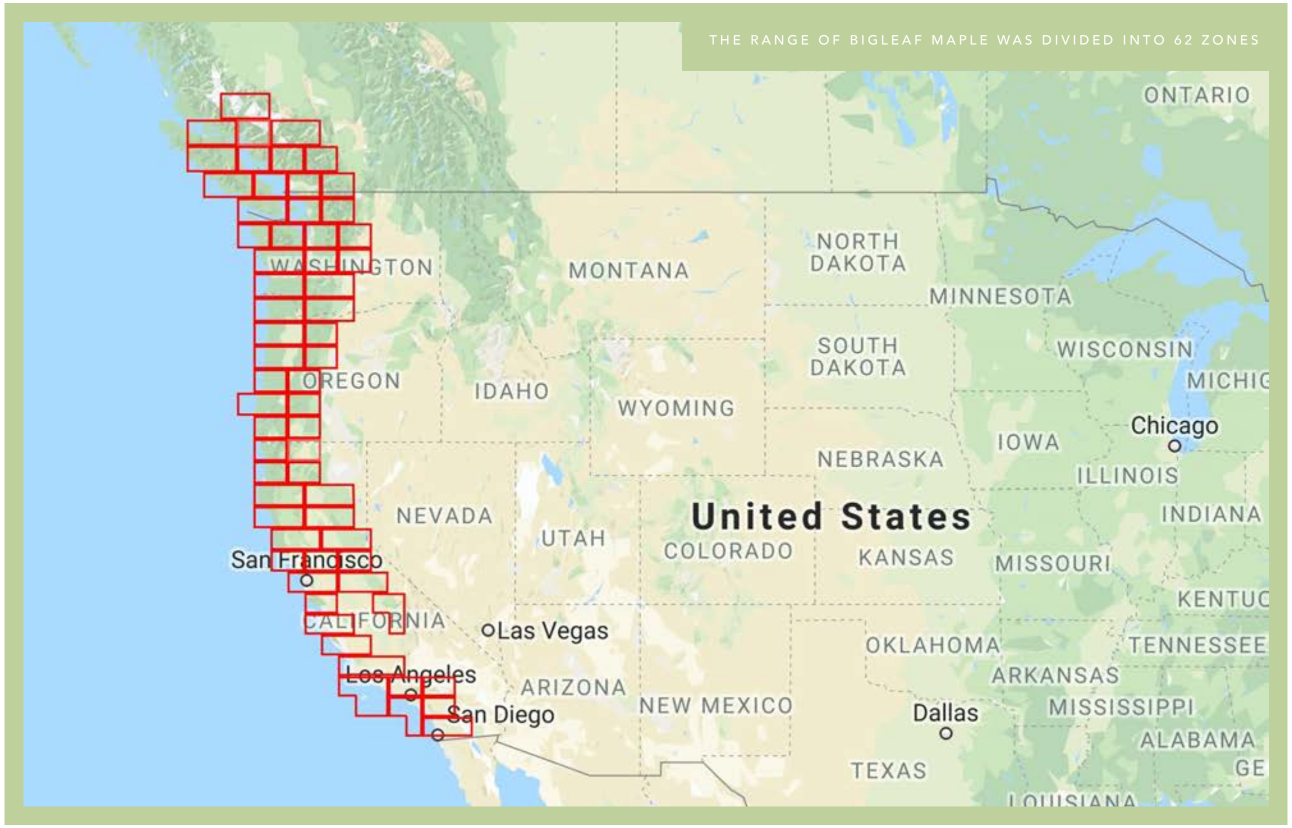
SAMPLING TARGETS

With an ambitious goal of sampling from 1,000 bigleaf maples across the species' entire range, we first compared existing maps and geospatial datasets to create a best-available species range map. Using Q-GIS, we established a Leaf Crew zone map of 62 equal-area rectangles covering that range. We then established low, medium, and high sampling targets of 10, 15, or 20 trees based on the amount of bigleaf maple range contained within each zone. In addition, 15 Wood Crew zones were defined, each one overlapping two to five Leaf Crew zones. Wood Crew sampling targets were set at 5 or 10 trees, similarly based on the amount of bigleaf maple range contained within each zone.

SITE SELECTION AND PERMITTING

Rather than pre-determining thousands of potential field sites, Adventure Scientists supported volunteers in identifying their own field sites based on their local expertise as well as regional habitat guidelines and online geospatial resources such as land ownership layers and botanical databases.

Adventure Scientists and Meaghan Parker-Forney (WRI) worked in tandem to pursue permits and permission from numerous agencies to provide volunteers with access to as many potential field sites as possible. In total, the project secured sampling permits in 19 National Forests, 10 National Parks, three State Park agencies, one State Forest, one Bureau of Land Management State Office, and one regional open space district. In addition, we secured permission to sample on unencumbered Crown lands in British Columbia, on Washington State Department of Natural Resources Land, and within several county and regional parks.




SEAN BECKETT

VOLUNTEER MANAGEMENT

Adventure Scientists began recruiting for the Timber Tracking Project in February 2018 with social media posts and newsletter announcements to our existing network of supporters. We continued geographically-targeted recruiting throughout the summer months, relying heavily on sponsored social media posts and direct inquiries made with organizations, companies, and community groups based within the range of bigleaf maple. Potential volunteers could choose to apply for either

Wood Crew or Leaf Crew. On our website, we provided brief descriptions about these distinct volunteer experiences, detailing how Wood Crew volunteers could expect more intensive training and fewer, more involved site visits over a larger area, while Leaf Crew volunteers would be required to visit a greater number of sites over a smaller total area. In total, we received applications from just over 300 volunteers, and we accepted over 150 volunteers to the project. In total, 20 Wood Crew volunteers and 90 Leaf Crew volunteers executed the protocols in the field.

Volunteers were trained using online modules specific to either Leaf Crew or Wood Crew. On average, volunteers spent one to three hours completing these trainings. Volunteers were given unlimited attempts to pass a post-training quiz with 100% accuracy in order to receive project equipment. After completing project trainings, volunteers attended mandatory post-training webinars, so they could interact with project staff and receive real-time answers to any unresolved questions. Later in the season as fewer volunteers were added to the project, we replaced this requirement with one-on-one phone calls with the Project Manager.

Adventure Scientists provided project equipment and a laminated protocol to volunteers. Leaf Crew equipment consisted of sampling packets, a saw-toss tool, alcohol wipes, and a lightweight measuring tape. Wood Crew equipment consisted of sampling packets, a plant press, an increment borer, a pole saw, a handsaw, a cleaning kit, and a lightweight measuring tape. Our project protocols emphasized data quality, environmental precautions, and volunteer safety. These documents

WOOD CREW EQUIPMENT CONSISTED OF SAMPLING PACKETS, A PLANT PRESS, AN INCREMENT BORER, A POLE SAW, A HANDSAW, A CLEANING KIT, AND A LIGHTWEIGHT MEASURING TAPE.

provided detailed instructions on how to prepare for field visits, identify bigleaf maples, collect high quality samples and metadata, disinfect equipment, and successfully transfer data and samples to Adventure Scientists upon leaving the field. One hundred percent of volunteers who responded to our end-of-season survey indicated that they were “provided with the necessary materials and training resources to be successful as a volunteer” (84% strongly agree and 16% agree). Additionally, we detected only 8 incidences of bigleaf maple misidentification out of 1,086 trees sampled for an error rate of less than 1%.

In addition to training and equipment, we provided our volunteers with several additional opportunities to engage further with the Timber Tracking Project. In late June, we hosted a “Meet the Experts” webinar, an in-depth discussion with research partners on the scientific underpinnings of the project. This optional but well-attended event provided a unique opportunity for interaction between our volunteers and scientific partners. Beginning in mid-July, we sent out bi-monthly newsletters to keep volunteers informed of progress and engaged throughout the field season. In August, we hosted an optional “Careers in Conservation” webinar and several opportunistically-located brewery meet-ups. We concluded the season with a “Happy Hour” webinar to celebrate and facilitate interaction between our geographically dispersed network of volunteers. In addition to these experiences, we rewarded our volunteers with Adventure Scientists garb, donated products, and pro-deal codes from our corporate partners. Over the course of the field season, Adventure Scientists gave away prizes associated with photo and video contests, webinar and quiz raffles, and the “September Sprint,” a late-season challenge to collect as many samples as possible.

LEAF CREW EQUIPMENT CONSISTED OF SAMPLING PACKETS, A SAW-TOSS TOOL, ALCOHOL WIPES, AND A LIGHTWEIGHT MEASURING TAPE

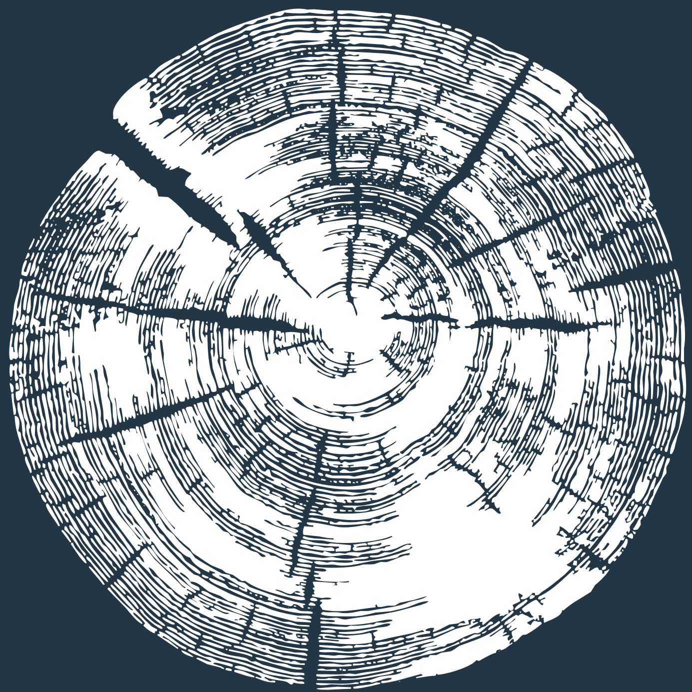
LEAF CREW VOLUNTEERS SUCCEEDED IN COLLECTING LEAF SEGMENT SAMPLES FROM 927 BIGLEAF MAPLES.

DATA COLLECTION & RESULTS

Leaf Crew volunteers succeeded in collecting leaf segment samples from 927 bigleaf maples. An additional 37 leaf samples were collected from a bigleaf maple research plot on Vancouver Island that contains trees grown from seeds sourced from a variety of bigleaf maple populations across British Columbia and Washington. Wood Crew volunteers sampled from an additional 96 trees, collecting 95 leaf segment samples, 85 cross-section samples, 93 core samples, and 81 sets of museum voucher specimens. The number of Wood Crew sample types varies because of instances where a volunteer was able to gather some, but

927

leaf samples



96

wood collections

not all, of the sample types (e.g. if a volunteer lacked access to a suitable branch for a cross-section sample). This final tally of samples excludes samples from 8 misidentified trees and 18 additional leaf samples and 3 sets of voucher specimens that regrettably were lost or destroyed in transit before they reached our offices. In 2019, we plan to make our collection locations and other metadata available in an interactive format on our project website, so that the scientific community, educators, and students may continue to explore and benefit from this data set.

Metadata at each collection site was recorded in the Magpi+ mobile app. This program allowed for the offline collection of data, critical for project implementation in remote and rural areas. Additionally, Magpi+'s barcode scanning capacity allowed us to implement a consistent naming convention for the vast majority of specimens by preventing typos and other errors. Both Leaf Crew and Wood Crew volunteers used the app to capture dates, GPS coordinates, tree-girth measurements, other sampling notes, and photos. The more extensive Wood Crew data form included additional questions on site and habitat characteristics to inform the creation of museum-grade labels for voucher specimens. All volunteers captured a photo of the intact leaf from which they sampled as means for Adventure Scientists staff to verify identification. To provide our scientific partners with additional contextual information about each collection site, Leaf Crew volunteers took one site photo, while Wood Crew volunteers captured a site photo in each cardinal direction.

Volunteers sent samples to Adventure Scientists' headquarters in Bozeman, Montana, typically within one week of being collected. We checked in each sample using a separate Magpi+ form to create a timestamped record of custody. By examining the leaf photo associated with each record, Adventure Scientists verified the identification of 97% of samples. We were unable to verify the identification of 3% of samples due to no leaf photo being attached to the record. After verification, samples were sent in batches to our lab-analysis partners.

ANYA TYSON

DATA END-USE

Collections from the 2018 season of the Timber Tracking Project will be used in the research and development of three distinct wood identification methodologies. David Erickson of DNA4 technologies is currently using next-generation sequencing (NGS) to analyze DNA from 400 leaf samples using the k-mer approach (Rahmen et. al. 2018). Erickson will also draft a paper about the extraction and analysis of DNA specifically from branch cross-sections with plans to submit this paper to peer review by early 2019. In 2019, Rich Cronn (USFS) will begin analyzing DNA from 800-1000 leaf-segment samples using the single nucleotide polymorphism or (SNP) approach (Gupta et. al. 2001). Ed Espinoza (USFWS) and Cady Lancaster

(USFS) at the USFWS Forensics Lab will use tree cores to create a reference library of bigleaf maple chemical fingerprints using the Direct Analysis in Real Time Mass Spectrometry (DART-TOFMS) approach (Cody et. al. 2005). In addition to contributing to their scientific fields, these collections will enable each of these researchers to establish new tools to support the successful prosecution of poachers and illegal traders of bigleaf maple in the future. New Mexico State University's Herbarium will process and house the voucher specimens that our Wood Crew volunteers collected and pressed. The vouchers will serve as a permanent record of the study, which will bolster the scientific and legal credibility of the collection effort.

DAMON TIGHE

VOLUNTEER EXPERIENCE

In total, our volunteers donated more than two years' worth of field days to this effort and hiked over 2,300 miles. Many of our volunteers reported that they gained a new appreciation for trees, forest environments, and for bigleaf maple specifically. After

"...Going into forests for me is a way of going into the mystery. So many cultures have seen trees as repositories of wisdom and truth. {...} To be able to linger longer and know better this amazing species is simply a joy."

GARY GRIFFITH

"[It] has been great to share our experiences and newfound excitement for spotting bigleaf maple trees."

GISELE GUERRA

"I have to admit that this project already has me seeing a species that I've ignored for years."

DAMON TIGHE

long searches in southern California, one volunteer wrote us: "[it] has been great to share our experiences and newfound excitement for spotting bigleaf maple trees." Another volunteer with previous expertise in plant identification related: "I have to admit that this project already has me seeing a species that I've ignored for years." When asked about his motivation to participate in the project in one of our project webinars, another volunteer related "I live surrounded by forest here in the Sierra Nevada foothills. Going into forests for me is a way of going into the mystery. So many cultures have seen trees as repositories of wisdom and truth. {…} To be able to linger longer and know better this amazing species is simply a joy." Over 80% of the 57 respondents to our end-of-season volunteer survey indicated that the project increased their awareness and knowledge of the illegal timber trade, and more than two-thirds of respondents reported that they have undertaken conservation actions as a result of the project.

ANYA TYSON

LESSONS LEARNED

PERMITTING

In partnership with WRI, Adventure Scientists began pursuing permits and permissions for this collection effort in February 2018. Across the board, this process required more legwork and time than was anticipated and would have ideally began earlier in the year. Due to the differing amounts of staff time that federal and state agencies could commit to permitting, initiating and finalizing a permit request sometimes required tens of emails and phone calls. Bigleaf maple's status as a host species for Sudden Oak Death, *Phytophthora ramorum*, a federally regulated pathogen, introduced additional regulatory hurdles. As a result of these challenges, several regions within our study area lacked the necessary permits and permissions to collect samples until June, or in some cases, July. In many instances, these delays significantly shortened the window of opportunity for volunteers to get into the field.

WILDFIRE

Devastating wildfires represented one of the biggest challenges to this sampling effort. Volunteers across California, Oregon, Washington, and British Columbia frequently faced poor air quality and dealt with shifting and reduced access to many forested areas. Based out of Redding, California, one of our volunteer teams had to evacuate their home for several weeks, and another volunteer in Washington state was forced to resign from the project due to air-quality-related health issues. Predictably, one spatial gap in our data set coincided with the Mendocino Complex fire, the largest wildfire in California history. In the future, we plan to communicate with volunteers more thoroughly about the need to prioritize sampling as early in the season as possible before these challenges arise.


LAUREN HERBINE

DETERIORATING SAMPLE CONDITION

While our project trainings emphasized gathering samples early in the season, over 250 samples, or around one quarter of the larger collection effort, were gathered in September and October. We acknowledge that the condition of sampling leaves generally deteriorated beginning in August. More specifically, the leaves our volunteers collected later in the season more often showed signs of fungal or bacterial growth and/or insect activity. Collections in Washington were especially affected by widespread evidence of Bigleaf Maple Decline, an affliction of unknown origin that affects leaf condition. In general, we decided that suboptimal samples were better than no samples at all, and we coached our volunteers to gather the best late-season samples available given the conditions in their regions. We are eager to learn how varying leaf condition affects the success rate of DNA extraction in the lab, and to incorporate any resulting lessons into the protocols of future phases of this project.

MAGPI+ APP

Slightly over 40% of the respondents to our end-of-season survey described experiencing difficulty with the Magpi+ data collection app, ranging from minor glitches to a few instances of data loss. For some participants, the app would crash unexpectedly, while others noticed errors in the GPS coordinates the app recorded at some sampling sites. During the season, the Adventure Scientists Technology Coordinator tirelessly addressed issues with the app, serving as the conduit between affected volunteers and Magpi's tech support system. Some issues were resolved with the installation of a smartphone or app update, while other issues required additional layers of troubleshooting with the Magpi+ app developers. Late in the season, we were pleased that Magpi+ added an accuracy measurement to their GPS field per our request — a feature that will be critical to preventing geospatial inconsistencies in the future. Based on an end-of-season spatial audit, we determined that over 81% of the geospatial data collected within the Magpi+ app is likely highly accurate, that 16% of the geospatial data may only be accurate within 30 meters, and that 3% of the geospatial data may contain inaccuracies greater than 0.5km. In our final data set, known geospatial inconsistencies have been addressed by replacing inaccurate coordinates with more accurate coordinates whenever possible.

Another major challenge occurred in October when Magp+i migrated to Amazon web servers. At this time, the links connecting leaf and site photos with 247 metadata records were severed due to a glitch. After investing significant staff time into resolving the issue, we eventually recovered the photos for 162 of these records. Still, some 224 photos associated with 86 records were not recovered. However, we were able to verify the correct identification in 66 out of the 86 records before the data loss occurred.

WOOD CREW VOLUNTEERS COLLECTED 81 SETS OF MUSEUM-QUALITY VOUCHER SPECIMENS.

Despite these difficulties, the Magpi+ system was an asset to the project. Its ability to scan barcodes allowed us to track samples from the field to the lab with consistent naming conventions and associated timestamps. Additionally, when the app performed well, as it did for the majority of participants, data transferred seamlessly into a secure back-end database.

CROSS-SECTION SAMPLE PACKAGING

Excluding voucher specimens stored in plant presses, all sample types were packaged in zip-top bags with silica desiccant to prevent fungal growth. However, many of our branch cross-section samples still grew mold due to the high amounts of moisture they contained within the wood itself. Fortunately, Erickson (DNA4 Technologies) was successful in obtaining uncontaminated DNA from the majority of these specimens. Though we adjusted our approach mid-season by adding more desiccant to these packages, we recommend using a more breathable material for packaging cross-section samples in the future.

DETERMINING SAMPLING LOCATIONS

Over 50% of our survey respondents experienced difficulty determining sampling locations due to limited access, permits, and the distribution of bigleaf maple. In zones containing large urban centers, the high proportion of private land often restricted the total permitted acreage available for collections. In many cases, Adventure Scientists pursued additional permits mid-season after identifying additional priority areas. Permits aside, some volunteers generally struggled to locate bigleaf maple, particularly in southern California and on other fringes of the species range. Online tools such as iNaturalist and CalFlora assisted some volunteers in determining sampling locations, while other volunteers described difficulties associated with these resources, including inaccuracies in geospatial information and instances where historic records led them to non-extant populations that had been destroyed by fire.

Lastly, the spatial dispersion required between sampling sites meant that driving between sites often made the most sense. We acknowledge the mismatch between this aspect of our study design and the desire, shared by many of our volunteers, to seamlessly incorporate data collection into their existing outdoor recreation routines. We also acknowledge that this unexpected reality increased the carbon footprint associated with this sampling effort. We believe this presents a powerful lesson learned for future phases of this work, when we will prioritize study designs that maximize human-powered modes of access to multiple sample sites.

CHRISTY CAROVILLANO

PROJECT MANAGER ANYA TYSON PERCHES ABOVE SOME PERFECT HABITAT FOR BIGLEAF MAPLE.

2019 AND BEYOND

In 2019, Adventure Scientists intends to focus the second phase of the Timber Tracking Project on western red cedar, yellow cedar, and coastal redwood, majestic conifers that all face significant poaching risk. We are intent on making the second season of the project even more productive and successful by incorporating lessons and feedback from this pilot season. We look forward to sharing the publications that will result from the project with volunteers, land management agencies, and the general public.

ACKNOWLEDGMENTS

We have boundless gratitude for our volunteers — their generosity, ingenuity, and enthusiasm never ceases to amaze. We're thankful specifically for the time and resources they invested in this project and their valuable feedback. The numerous land management agencies that assisted this effort by fielding our inquiries and permit requests also deserve our sincere appreciation, and we've listed them in Appendix 1. Additionally, Dr. Alvin Yanchuk was a gracious ally in helping us get the proper permissions for our collections in British Columbia. We also thank Dr. Yanchuk and Keith Bird for facilitating field work at the Skutz Falls research plots.

We are grateful to Norway's International Climate and Forest Initiative (NICFI) for funding this important proof-of-concept work and to World Resources Institute (WRI) for facilitating this prominent contribution. Specifically, we would like to thank Meaghan Parker-Forney (WRI) for collaborating with us at each step of the journey. We were also fortunate to collaborate with David Erickson (DNA4 Technologies), Brook Milligan (NMSU), Rich Cronn (USFS), Cady Lancaster (USFS), and Ed Espinoza (USFWS). We consider ourselves lucky to continue working alongside each of them in the fight against illegal logging.

We want to thank the many donors who supported the pilot year of this project as well as Adventure Scientists' other conservation endeavors. In addition to fueling our volunteers with delicious energy bars, CLIF Bar generously supported this effort through the CLIF Bar Family Foundation small grants program. GaiaGPS wowed us with their in-kind donation by waiving all subscription fees. Outdoor Prolink, Klean Kanteen, Peak Design, and Croakies helped us award our volunteers with great prizes throughout the field season. Insightful comments from Dr. Helen Bothwell and Dr. Tim McDermott greatly improved our project protocols. In house, every member of the Adventure Scientists team contributed their optimism, creativity, and exemplary work ethic to help launch this project. Special thanks go to Technology Coordinator Ricky Jones, Volunteer Communicator Jessie Kay, and Project Teams Intern Karissa Mielke, Pollinators Project Manager Michelle Toshack, Projects Team Lead Katie Christiansen, Director of Communications Andrew Howley, and Executive Director Gregg Treinish.

CATKINS AND YOUNG LEAVES EMERGE ON BIGLEAF MAPLE BRANCHES EARLY IN THE SPRING.

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APPENDIX 1

- Bureau of Land Management California State Office
- Region 6 of the United States Forest Service
- San Bernardino National Forest
- Los Padres National Forest
- Mendocino National Forest
- El Dorado National Forest
- Klamath National Forest
- Shasta-Trinity National Forest
- Plumas National Forest
- Six Rivers National Forest
- Tahoe National Forest
- Angeles National Forest
- Stanislaus National Forest
- Sequoia National Forest
- Sierra National Forest
- Cleveland National Forest
- Lassen National Forest
- Jackson Demonstration State Forest
- Channel Islands National Park
- Redwood National Park
- California State Parks – Sonoma Mendocino Coast, Angeles, Santa Cruz, California Desert, Inland Empire, Monterey, North Coast Redwoods, Bay Area, San Luis Obispo Coast, Gold Fields, Sierra Districts and Hollister Hills State Vehicular Area.
- Point Reyes National Seashore
- Golden Gate National Recreation Area
- Yosemite National Park
- Sequoia-Kings Canyon National Park
- Whiskeytown National Recreation Area
- Olympic National Park
- North Cascades National Park
- Midpeninsula Regional Open Space District
- Oregon State Parks
- Washington State Parks
- Oregon Bureau of Land Management – Salem, Medford, Roseburg, & Coos Bay Districts
- Elliot State Forest
- Washington Department of Natural Resources
- British Columbia Ministry of Forests, Lands, Natural Resource Operations and Rural Development

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